EXHIBIT 1

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Yamagishi et al.

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[54] **GOLF BALL**

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[58] **Field of Search** ..... 473/372, 373, 473/351, 377, 385, 370, 374, DIG. 22

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[57] **ABSTRACT**

A solid golf ball comprising a core and a cover is provided. The core has a core hardness expressed by a distortion of 2.2–4.0 mm under a load of 100 kg. The core hardness divided by the ball hardness ranges from 1.0 to 1.3. The cover has a thickness of 1.3–1.8 mm. The ball is improved in feel and spin while maintaining the flying distance inherent to solid golf balls.

2 Claims, 1 Drawing Sheet

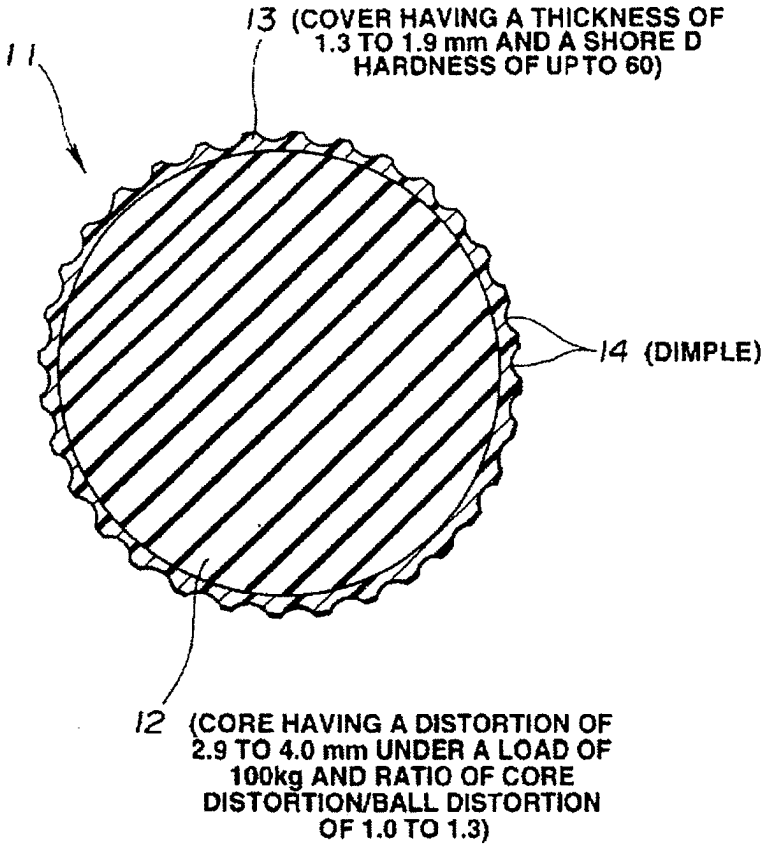
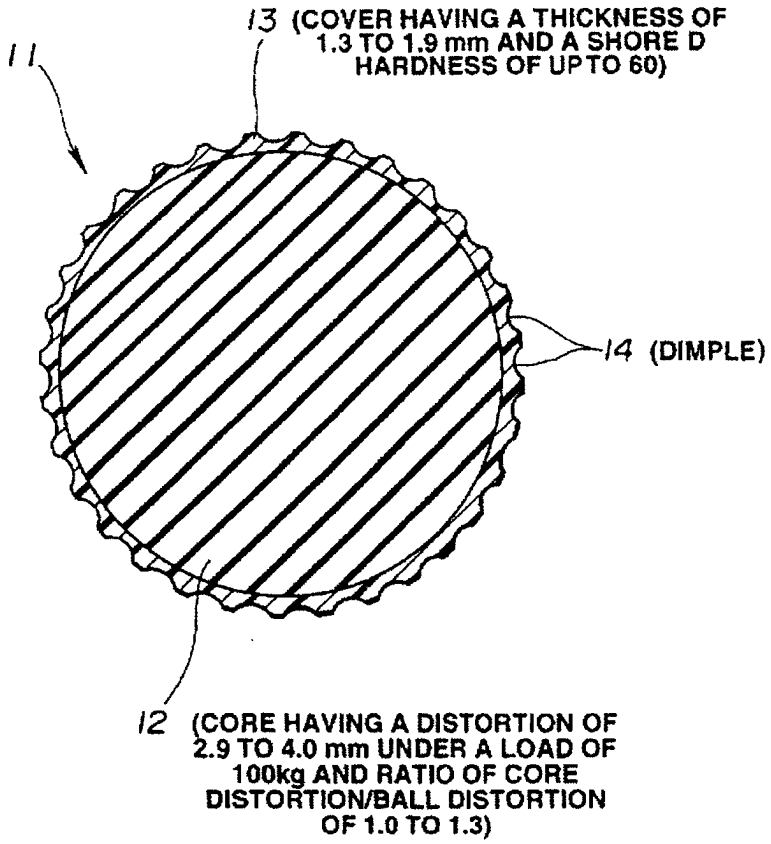


FIG.1


11
13 (COVER HAVING A THICKNESS OF 1.3 TO 1.9 mm AND A SHORE D HARDNESS OF UP TO 60)
14 (DIMPLE)
12 (CORE HAVING A DISTORTION OF 2.9 TO 4.0 mm UNDER A LOAD OF 100kg AND RATIO OF CORE DISTORTION/BALL DISTORTION OF 1.0 TO 1.3)

GOLF BALL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a solid golf ball having improved feel and spin performance.

2. Prior Art

As compared with wound golf balls, two-piece golf balls and other solid golf balls are advantageous in gaining a flying distance since they fly along the trajectory of a straight ball when hit by both drivers and irons. This advantage is mainly attributable to their structure. Because of their configuration less receptive to spin, the solid golf balls are given a straight ball trajectory and yield a more run, resulting in an increased total flying distance.

In turn, the solid golf ball tends to draw a "flier" path on an iron shot since it is less receptive to spin and does not readily stop on the green. Because of such characteristics, the two-piece balls are not preferred by experienced players.

Therefore, there is a need for a solid golf ball having improved spin properties and allowing the player to aim the pin dead with an iron. The increased flying distance inherent to the solid golf ball should be maintained and of course, the ball should have a pleasant feel.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a solid golf ball such as a two-piece golf ball which is improved in feel, spin properties and iron control without detracting from the trajectory and flying distance inherent to the solid golf ball. The term iron control is the controllability of a ball on an iron shot, more specifically stop on the green.

Briefly stated, the present invention pertains to a solid, typically two-piece, golf ball comprising a core and a cover enclosing the core. The hardness of the core, cover and ball are referred to as core hardness, cover hardness, and ball hardness, respectively. According to the invention, the core hardness is such that the core undergoes a distortion of at least 2.2 mm under a load of 100 kg. The core hardness divided by the ball hardness is in the range of 1.0 to 1.3. The cover has a radial thickness of 1.3 to 1.8 mm. This parameter control leads to a golf ball satisfying the requirements of flying distance, feel and spin.

Consider the spin mechanism of golf balls made of the same materials, but changed in hardness. Provided that the club head speed and the cover material are identical, the coefficient of friction between the ball and the club face is identical and hence, an identical frictional force is exerted therebetween. Only distortion is different due to differential hardness. Then the distance between the center of gravity and the ball-club contact point is different. The harder the ball, the longer is the contact point distance. The softer the ball, the shorter is the contact point distance. Then harder balls are more receptive to spin.

The spinning mechanism associated with an iron suggests that the spin quantity can be increased by increasing the ball hardness. Increasing the ball hardness, however, gives a harder feel, exacerbating the hitting feel. The spin quantity can also be increased by making the cover softer. A softer cover, however, deprives the ball of repulsion, resulting in a loss of initial speed and flying distance.

Attempting to increase the spin quantity for improving spin properties by using a soft material, typically a material having a Shore D hardness of 60 or lower as the cover, we found that a low hardness cover lowers repulsion, resulting in a loss of flying distance on hitting. Quite unexpectedly, we have found that by adjusting the core hardness to a distortion of at least 2.2 mm under a load of 100 kg, the ratio of core hardness to ball hardness to range from 1.0 to 1.3 and the cover thickness to range from 1.3 mm to 1.8 mm, the golf ball, whose cover is made of a softer material, is improved in iron control (that is, stop on the green) without deterring the feel and flying distance and without losing the trajectory and flying distance on a driver shot inherent to solid golf balls.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic cross section illustrating one embodiment of the golf ball of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the golf ball comprising a spherical solid core enclosed in a cover according to the present invention, the core hardness is at least 2.2 mm as expressed by a distortion under a load of 100 kg, the core hardness divided by the ball hardness is in the range of 1.0 to 1.3 and the cover has a thickness of 1.3 to 1.8 mm.

The core hardness and ball hardness are defined by distortions (in mm) of the core and ball under a load of 100 kg, respectively. The core hardness corresponds to such a distortion of at least 2.2 mm, preferably at least 2.5 mm, more preferably 2.5 to 4.0 mm, most preferably 3.0 to 4.0 mm. With a core distortion of less than 2.2 mm, the feel becomes unpleasant. Too much core distortions would result in balls having poor restitution, low flying performance and a too soft feel. By controlling the core hardness/ball hardness so as to fall in the range between 1.0 and 1.3, especially between 1.0 and 1.25, the solid golf ball, typically two-piece golf ball is improved in feel, flying distance and spin characteristics. If the core hardness/ball hardness is less than 1.0, the feel becomes unpleasant. If the core hardness/ball hardness exceeds 1.3, the ball loses a quick stop on the green.

It is understood that the golf ball of the invention is advantageously applied to two-piece golf balls having a single core. It is also applicable to multi-core golf balls having a core consisting of two or more layers, such as three-piece golf balls. In an example where the core consists of two inner and outer layers, the core hardness refers to the hardness of the spherical two-layer core as a whole. Differently stated, the core hardness refers to the hardness of an entire spherical core left after removing the cover from the ball.

The cover has a Shore D hardness of up to 60, especially 55 to 60. A cover hardness of more than 60 would adversely affect spin characteristics and stop on the green. Since a cover with too low hardness would result in poor repulsion and a loss of flying distance, the lower limit of 55 is recommended for the cover hardness.

According to the invention, the cover has a radial thickness of 1.3 to 1.8 mm, especially 1.4 to 1.8 mm. Outside the range, the objects of the invention cannot be achieved. A cover of thinner than 1.3 mm is less resistant against top damage and liable to be broken. A cover of thicker than 1.8 mm leads to losses of repulsion and flying performance and gives a dull feel.

In general, the flying distance the ball covers depends on the head speed. The flying distance is reduced by a change from a higher head speed to a lower head speed. The degree

of reduction of the flying distance by a change from a higher head speed to a lower head speed can be suppressed by limiting the cover thickness to the above-defined range. Differently stated, the dependency of flying distance on head speed is alleviated. Therefore, the ball of the invention is suitable for senior and female players who swing at a relatively low head speed.

In one preferred embodiment of the invention, the golf ball has a spin factor of 1.0 to 1.5. The spin factor is defined as follows. The golf ball has a spin quantity when hit by a pitching wedge (referred to as wedge spin quantity) and a spin quantity when hit by a driver (referred to as driver spin quantity). The spin factor is obtained by dividing the ratio of the wedge spin quantity to the driver spin quantity by the ball hardness. Then a spin factor smaller than unity means that the ball has greater spin with the driver and less spin with the pitching wedge. The former indicates that the trajectory is lofted and the flying distance is reduced. The latter indicates that when hit with an iron, the ball draws a flier-like trajectory and flies too much. A greater spin factor is then desirable. Then the object of the invention to render the ball receptive to less spin with a driver and more spin with an iron is effectively accomplished. However, a too greater spin factor would exacerbate ball control on an iron shot because the ball can be moved back too much due to back spin. For this reason, the spin factor is preferably in the range between 1.0 and 1.5.

The golf ball of the invention is advantageously applied to two-piece golf balls while it is also applicable to multi-core golf balls such as three-piece golf balls. The material and preparation of the core and cover are not critical. The components may be made of any of well-known materials insofar as the requirements of the invention are met. Of course, the golf ball of the invention has a standard size and weight.

More particularly, the core of the present solid golf ball is formed from a rubber composition by a conventional method while properly adjusting the component proportion and vulcanizing conditions. The core composition generally includes a base rubber, a crosslinking agent, a co-crosslinking agent, an inert filler, and other components. The base rubber may be selected from natural and synthetic rubbers conventionally used in the manufacture of solid golf balls. Preferably the base rubber is 1,4-polybutadiene rubber containing at least 40% of cis-configuration, optionally in admixture with natural rubber, polyisoprene rubber or styrene-butadiene rubber. The crosslinking agent is preferably selected from organic peroxides such as dicumyl peroxide and di-t-butyl peroxide, with the dicumyl peroxide being more preferred. Preferably the crosslinking agent is blended in an amount of about 0.5 to 3 parts, more preferably about 0.8 to 1.5 parts by weight per 100 parts by weight of the base rubber. Non-limiting examples of the co-crosslinking agent include metal salts of unsaturated fatty acids, especially zinc and magnesium salts of unsaturated fatty acids having 3 to 8 carbon atoms, such as acrylic acid and methacrylic acid. Zinc acrylate is the most preferred salt. The co-crosslinking agent is preferably blended in an amount of about 24 to 38 parts, more preferably about 28 to 34 parts by weight per 100 parts by weight of the base rubber. Examples of the inert filler include zinc oxide, barium sulfate, silica, calcium carbonate, and zinc carbonate, with the zinc oxide being most often used. The amount of the filler blended depends on the desired specific gravity of the core and cover, ball weight, and other factors although it generally ranges from about 10 to about 60 parts by weight per 100 parts by weight of the base rubber.

These components are blended to form a core-forming rubber composition which is kneaded by means of a conventional kneading machine such as a Banbury mixer and roll mill and then compression or injection molded in a spherical mold cavity. The molded composition is cured by heating it at a sufficient temperature for the crosslinking and co-crosslinking agents to exert their function (for example, about 130° to 170° C. when the crosslinking agent is dicumyl peroxide and the co-crosslinking agent is zinc acrylate). In this way, a solid spherical core having a diameter of 37 to 40 mm is prepared.

In the case of a two layer core, the inner core may be made of the same composition as above and the outer core may be made of a similar rubber composition or a resin composition based on an ionomer resin or the like. The outer core may be formed by compression molding or injection molding it around the inner core. Typically the inner core has a diameter of 27.0 to 38.0 mm, preferably 28.0 to 36.0 mm and the outer core has a diameter of 0.5 to 6.5 mm, preferably 1.5 to 5.5 mm, and the total diameter ranges from 37 to 40 mm.

The solid core is enclosed with the cover by any desired technique, for example, by enclosing the core in a pair of semi-spherical shell halves followed by heat compression molding. Alternatively the core is directly covered with a cover material by injection molding. By properly selecting the material and amount of the core and cover and preparation conditions such as vulcanizing conditions, a golf ball satisfying the requirements of the invention can be prepared.

There has been described a golf ball which is improved in feel and spin characteristics while maintaining the flying distance inherent to solid golf balls and which undergoes a lower degree of reduction of its flying distance upon hitting at a lower head speed.

EXAMPLE

Examples of the present invention are given below by way of illustration and not by way of limitation.

Examples 1–6 and Comparative Examples 1–2

Cores having a hardness as shown in Table 1 were molded by vulcanizing in a mold rubber compositions comprising cis-1,4-polybutadiene rubber, zinc acrylate, zinc oxide, and dicumyl peroxide. The core hardness reported is a distortion in millimeter under a load of 100 kilograms.

The cores were enclosed with covers which were formed from mixtures of ionomer resins. The blending proportion of ionomer resins was changed to form covers having varying hardness (Shore D scale) as shown in Table 2. In this way, there were obtained large-size two-piece golf balls having a hardness as shown in Table 3. The ball hardness reported is again a distortion in millimeter under a load of 100 kilograms.

The base composition for the core consisted of the following components.

	Parts by weight
cis-1,4-polybutadiene rubber (BR01)	100
zinc acrylate	33.2
zinc oxide	10
barium sulfate	9.7
anti-oxidant	0.2
dicumyl peroxide	0.9

Cores having varying hardness and specific gravity were obtained by varying the amounts of zinc acrylate and barium sulfate as shown in Table 1.

TABLE 1

Core hardness	Cover gage 1.4 mm	1.6 mm	1.8 mm	2.0 mm	2.4 mm
2.48–2.50 mm	33.0	33.0	33.0	33.0	
	6.4	7.5	8.6	9.7	
2.88–2.91 mm	31.0	31.0	31.0	31.0	31.0
	7.8	8.8	9.9	11.0	13.9
3.25–3.30 mm	28.0	28.0	28.0	28.0	
	9.1	10.2	11.2	12.3	

At the upper and lower stages for each core hardness and cover gage combination, the amounts of zinc acrylate and barium sulfate are reported in parts by weight, respectively.

The base composition for the cover was a 50/50 (by weight) mixture of ionomer resins, Himilan 1650 and Surlyn 8120. Covers having varying hardness were obtained while blending Himilan 1650 and Surlyn 8120 in a ratio as shown in Table 2.

TABLE 2

Cover hardness (Shore D)	Resin mix	Weight ratio
56	H1650/S8120	40/60
57	H1650/S8120	50/50
65	H1605/H1706	50/50

* H: Himilan commercially available from du Pont-Mitsui Polychemical Co., Ltd.
S: Surlyn commercially available from E. I. duPont

The golf balls were examined for fly, stop on the green, and feel by the following procedures.

Fly Test

Using a swing robot manufactured by True Temper Co., the ball was hit by a driver at a head speed (HS) of 45 m/s and by an iron at a head speed of 35 m/s to measure the flying distance.

Stop on the Green Test

Using a swing robot manufactured by True Temper Co., the ball was hit by a pitching wedge at a head speed of 35 m/s so as to fly directly on the green. The distance between the landing and stop positions was measured. A negative value is the distance the ball covers due to back spin. A positive value is a run in a flying direction. The stop on the green was rated "O" for quick stop and "X" for non-stopping.

Feel Test

In a sensory test, a player hit the ball at a head speed (HS) of 35 m/s. The ball feel was rated "very soft", "soft" or "hard".

Note that the dependency of flying distance on head speed is expressed by the flying distance at a head speed of 35 m/s divided by the flying distance at a head speed of 45 m/s and simply reported under the heading "HS35/HS45" in Table 3.

TABLE 3

	Example 1	2	3	4	5	6	Comparative Example 1	2
Core hardness (mm)	2.48	3.30	2.50	2.90	2.91	3.25	2.10	2.85
Ball hardness (mm)	2.36	3.10	2.30	2.71	2.65	2.90	1.90	2.10
Core/ball hardness ratio	1.05	1.06	1.09	1.07	1.10	1.12	1.11	1.36
Cover thickness (mm)	1.4	1.4	1.6	1.6	1.8	1.8	1.8	2.4
Cover hardness (Shore D)	56	57	56	56	56	57	57	65
Feel @ HS35	soft	very soft	soft	very soft	soft	very soft	hard	soft
Flying distance (m)								
@ HS 35	154	160	154	158	157	159	147	148
@ HS 45	234	237	232	233	233	236	228	235
Stop on the green								
Landing-to-stop distance (m)	-0.5	0.5	0.0	0.0	0.0	0.5	0.0	2.5
Rating	o	o	o	o	o	o	o	x
HS35/HS45	0.658	0.675	0.664	0.678	0.674	0.673	0.645	0.630

Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. A golf ball comprising a core and a cover wherein said core and said ball has a core hardness and a ball hardness respectively, wherein said core has a distortion of 2.9 to 4.0 mm under a load of 100 kg, the ratio of a core distortion under a load of 100 kg divided by a ball distortion under a load of 100 kg ranges from 1.0 to 1.3, and said cover consists of an ionomer resin as a resin component and has a thickness of 1.3 to 1.8 mm and a Shore D hardness of up to 60.

2. The golf ball of claim 1 wherein said cover has a thickness of 1.6 to 1.8 mm.

* * * * *

EXHIBIT 2

REDACTED

EXHIBIT 3

REDACTED

EXHIBIT 4

⑲日本国特許庁(JP) ⑪特許出願公開

⑫公開特許公報(A) 昭60-163673

⑤1Int.Cl.⁴ 識別記号 庁内整理番号 ⑬公開 昭和60年(1985)8月26日
A 63 B 37/00 2107-2C

審査請求 未請求 発明の数 1 (全4頁)

⑭発明の名称 ソリッドゴルフボール

⑳特 願 昭59-20418
㉒出 願 昭59(1984)2月7日

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明 細 書

1．発明の名称

ソリッドゴルフボール

2．特許請求の範囲

1．高分子配合材料により形成されたソリッドコアとこのソリッドコアを被覆するアイオノマー樹脂を主体としたカバーとを具備するソリッドゴルフボールにおいて、ソリッドコアとして100kg定荷重における変形量が1．5～4mmのものを用いると共に、カバーとして曲げ剛性が500～4000kg/cm²の材料により厚さ0．7～3mmに形成したものを用いたことを特徴とするソリッドゴルフボール。

2．ソリッドコアとして100kg定荷重における変形量が1．8～2．2mmのものを用いると共に、カバーとして曲げ剛性が700～4000kg/cm²の材料により厚さ1．0～1．9mmに形成したものを用いた特許請求の範囲第1項記載のソリッドゴルフボール。

3．ソリッドコアとして100kg定荷重における変形量が2．3～2．7mmのものを用いると共に、カバーとして曲げ剛性が700～4000kg/cm²の材料により厚さ1．5～2．0mmに形成したものを用いた特許請求の範囲第1項記載のソリッドゴルフボール。

4．ソリッドコアとして100kg定荷重における変形量が2．8～3．2mmのものを用いると共に、カバーとして曲げ剛性が900～4000kg/cm²の材料により厚さ1．7～2．3mmに形成したものを用いた特許請求の範囲第1項記載のソリッドゴルフボール。

5．ソリッドコアとして100kg定荷重における変形量が3．3～3．7mmのものを用いると共に、カバーとして曲げ剛性が1000～4000kg/cm²の材料により厚さ1．9～2．4mmに形成したものを用いた特許請求の範囲第1項記載のソリッドゴルフボール。

3．発明の詳細な説明

本発明はソリッドコアをアイオノマー樹脂製の

カバーで被覆したツーピースゴルフボール等のソリッドゴルフボールに関し、更に詳述すると打撃感触が良く、かつ耐久性に優れたソリッドゴルフボールに関する。

従来より、ポリブタジエンゴム、メタクリル酸、酸化亜鉛、過酸化物等を混練してこれを加熱成形したソリッドコアにカバーを被覆したツーピースゴルフボールなどのソリッドゴルフボールが知られている。このようなツーピースゴルフボールなどのソリッドゴルフボールは、通常優れた耐カット性を有するアイオノマー樹脂製のカバーを使用しているため、耐久性に優れているが、糸巻きボールに比べて打撃感触が悪いという欠点を有している。このため、従来このようなソリッドゴルフボールの打撃感触をソフトにすることを目的として①ソリッドコアの硬度を下げる、②耐カット性カバーを薄くする、③耐カット性カバーを軟らかい材料で形成する、といった方法が提案されている。しかしながら、①又は②の方法を採用したボールは耐久性が劣り、打撃時にボールが切れ易くなり、また③の方法を採用したボールは打撃初速が劣るという問題を有している。

本発明者らは、上記事情に鑑み、打撃感触が良く、かつ耐久性に優れしかも打撃初速の大きいソリッドゴルフボールを得るために鋭意検討を行なった結果、高分子配合材料により形成されたソリッドコアとこのソリッドコアを被覆するアイオノマー樹脂を主体としたカバーとを具備するソリッドゴルフボールにおいて、ソリッドコアとして100kg定荷重における変形量が1.5～4mmのものを用いると共に、カバーとして曲げ剛性が500～4000kg/cm²の材料により厚さ0.7～3mmに形成したものを用いることにより、上記目的が効果的に達成されることを知見した。

即ち、本発明者らは、ソリッドゴルフボールの打撃感触をソフトにするために単にソリッドコアの硬度を下げたり、カバーを薄くしたのでは耐久性が悪くなり、また単にカバーを軟らかくしたのでは打撃初速が低下するのに対し、上記範囲の硬さを有するソリッドコアと上記範囲の曲げ剛性、厚さを有するカバーとを組み合せた場合、意外にも打撃感触がソフトになるにもかかわらず耐久性が低下することがなく、しかも打撃初速が低下せず、従ってコアの硬さ、カバーの曲げ剛性及びカバーの厚さの組み合せを特定のものとすることにより糸巻きボールと同等の打撃感触を有するゴルフボールが得られることを知見し、本発明をなすに至ったものである。

以下、本発明につき更に詳しく説明する。

本発明に係るソリッドゴルフボールは、高分子配合材料により形成されたソリッドコアとこのソリッドコアを被覆するアイオノマー樹脂を主体とするカバーとを具備するソリッドゴルフボールにおいて、ソリッドコアとして100kg定荷重における変形量が1.5～4mmのものを用いると共に、カバーとして曲げ剛性が500～4000kg/cm²の材料により厚さ0.7～3mmに形成したものを用いたものである。なお、ここで100kg定荷重における変形量とは、球形のソリッドコアに100kgの荷重をかけた場合のボールの変量を示し、また曲げ剛性はASTM D-790-4により測定した値を示すものである。

この場合、本発明ゴルフボールにおいては、ソリッドコアとして100kg定荷重における変形量が1.8～2.2mmのものを用いた場合はカバーを曲げ剛性が700～4000kg/cm²の材料を用いて厚さ1.0～1.9mmに形成し、ソリッドコアとして100kg定荷重における変形量が2.3～2.7mmのものを用いた場合はカバーを曲げ剛性が700～4000kg/cm²の材料を用いて厚さ1.5～2.0mmに形成し、ソリッドコアとして100kg定荷重における変形量が2.8～3.2mmのものを用いた場合はカバーを曲げ剛性が900～4000kg/cm²の材料を用いて厚さ1.7～2.3mmに形成し、ソリッドコアとして100kg定荷重における変形量が3.3～3.7mmのものを用いた場合はカバーを曲げ剛性が1000～4000kg/cm²の材料を用いて厚さ1.9～2.4mmに形成することが特に好ましく、ソリッドコアの硬さ、カバーの曲げ剛性、厚さを

上記範囲とすることにより更に確実に打球感触の良いボールを得ることができる。

本発明において、上述した範囲の100kg定荷重における変形量を有するソリッドコアを形成する高分子配合材料の組成に特に制限はないが、ポリブタジエンゴムを不飽和カルボン酸又はその金属塩で架橋硬化したもの、ポリブタジエンゴムを不飽和カルボン酸エステルで架橋硬化したもの、ポリブタジエンゴムを不飽和カルボン酸又はその金属塩と不飽和カルボン酸エステルとを併用して架橋硬化したもの等が好適に使用し得る。また、上記組成において、酸化亜鉛、有機過酸化物、充填剤等の他の成分を適宜割合で配合しても差支えない。具体的には、例えばシス1，4結合を有するポリブタジエンゴム100重量部、アクリル酸及び／又はメタクリル酸10～30重量部、酸化亜鉛10～70重量部並びに過酸化物0．5～6重量部から成る組成物を加熱硬化したものを好適に使用し得る。

なお、ソリッドコアは、スモールサイズの場合は通常直径36．4～37．4mm、重量35．4～36．2g、ラージサイズの場合は通常直径37．4～38，4mm、重量33．4～34．2gに形成するものである。

また、本発明においてはカバーを形成する材料としてアイオノマー樹脂を主体としたものを用いるもので、このようなアイオノマー樹脂を主体としたものの中から曲げ剛性が500～4000kg／cmのものを適宜選択して使用することができる。この場合、カバー材料の組成は特に制限されず、例えばアイオノマー樹脂に二酸化チタン、酸化亜鉛、ステアリン酸亜鉛、ステアリン酸マグネシウム等の無機充填剤などを配合したものを用いることができる。なお、アイオノマー樹脂としては、モノオレフィンと炭素原子数3～8の不飽和モノ又はジカルボン酸及びそれらのエステルからなる群より選ばれる1種又は2種以上との混合体に交叉金属結合を付与したものが好適に用いられる。

本発明においては、ソリッドコアは通常の方法により成型することができ、例えば上述したソリッドコアの材料をバンバリーミキサーやロール等の通常の混練機を用いて混練した後、これをコア用金型に圧縮或いは射出成型し、この成型体を加熱することにより成型することができる。ここで、加熱温度は、例えばコア材料中に過酸化物としてジクミルパーオキサイドを配合した場合は140～180℃とすることができる。また、カバーをソリッドコアに被覆する方法も特に制限されず、例えばあらかじめ半球殻状に成型した一対のカバーでソリッドコアを包み、加熱成型して一体化する方法や、芯球の周囲にカバー材を射出成型して一体化する方法などを採用し得る。

以上述べたように、本発明に係るソリッドゴルフボールは、高分子配合材料により形成されたソリッドコアとこのソリッドコアを被覆するアイオノマー樹脂を主体としたカバーとを具備するソリッドコアゴルフボールにおいて、ソリッドコアとして100kg定荷重における変形量が1．5～4mmのものを用いると共に、カバーを曲げ剛性が500～4000kg／cmの材料を用いて厚さ0．7～3mmに形成したことにより、打撃感触がソフトで良好であると共に、耐久性に優れ、しかも打撃初速が大きいものである。

次に、実施例及び比較例を示し、本発明を具体的に説明する。

〔実施例，比較例〕

ポリブタジエンゴム100重量部、酸化亜鉛20～80重量部、アクリル酸10～30重量部及びジクミルパーオキサイド0．5～4重量部からなる組成物を1000ccバンバリーミキサーで混練し、150℃で40分間加圧成型して直径36～40mm、100kg定荷重における変形量が2．0～3．5mmの種々のソリッドコアを作成した。

次いで、アイオノマー樹脂100重量部及び二酸化チタン20重量部からなるカバー材料を上記ソリッドコアに射出成型して、第1表乃至第4表に示す曲げ剛性、厚さを有するカバーをコアに被覆したツーピースゴルフボールをそれぞれ得た。ここで、アイオノマー樹脂としてはハイミラン®

の中から様々の曲げ剛性を有するものを選択して使用した（第１～４表に使用したハイミラン®の製品番号を併記する）。なお、第１表は１００kg定荷重における変形量が１．８～２．２mmのソリッドコアを用いた場合、第２表は同変形量が２．３～２．７mmのソリッドコアを用いた場合、第３表は同変形量が２．８～３．２mmのソリッドコアを用いた場合、第４表は同変形量が３．３～３．７mmのソリッドコアを用いた場合をそれぞれ示すものである。

次に、これらのツーピースボールを多くのプロゴルファーに試打させ、打撃時の感触を評価させた。結果を第１～４表に示す。なお、評価基準は下記の通りである。

評価基準

○ ： 打撃感触がソフトで非常に良い。

△ ： ○と×との中間の感触。

× ： 打撃感触が硬くて良くない。

第1表　100kg定荷重における変形量が1．8～2．2mmのソリッドコアを用いた場合

カバー厚さ (mm)	カバーの曲げ剛性 (kg/cm²) (ハイミラン®製品番号)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1．0	○	○	○	○	○	○
1．5	○	○	○	○	○	×
1．75	○	○	○	○	×	×
2．0	△	△	×	×	×	×
2．25	×	×	×	×	×	×

第2表　100kg定荷重における変形量が2．3～2．7mmのソリッドコアを用いた場合

カバー厚さ (mm)	カバーの曲げ剛性 (kg/cm²) (ハイミラン®製品番号)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1．0	×	×	△	△	△	△
1．25	△	△	△	△	△	△
1．5	○	○	○	○	○	×
1．75	○	○	○	○	○	×
2．0	○	○	×	×	×	×
2．25	×	×	×	×	×	×
2．5	×	×	×	×	×	×

第3表　100kg定荷重における変形量が2．8～3．2mmのソリッドコアを用いた場合

カバー厚さ (mm)	カバーの曲げ剛性 (kg/cm²) (ハイミラン®製品番号)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1．5	×	×	△	△	△	△
1．75	○	○	○	○	○	○
2．0	○	○	○	○	○	○
2．25	○	○	○	○	○	○
2．5	△	△	×	×	×	×

第4表　100kg定荷重における変形量が3．3～3．7mmのソリッドコアを用いた場合

カバー厚さ (mm)	カバーの曲げ剛性 (kg/cm²) (ハイミラン®製品番号)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1．5	×	×	×	△	△	△
1．75	△	△	△	△	△	△
2．0	○	○	○	○	○	○
2．25	○	○	○	○	○	○
2．5	△	△	△	△	△	×
2．75	△	△	△	△	×	×

第１～４表の結果より、本発明のソリッドゴルフボールは打撃感触がソフトで良好であることが認められた。また、１００kg定荷重における変形量が１．８～２．２mmのコアにカバーを曲げ剛性が７００～２０００kg／cm²の材料を用いて厚さ１．０～１．９mmに形成したもの、同変形量が２．３～２．７mmのコアにカバーを曲げ剛性が７００～２５００kg／cm²の材料を用いて厚さ１．５～２．０mmに形成したもの、同変形量が２．８～３．２mmのコアにカバーを曲げ剛性が９００～４０００kg／cm²の材料を用いて厚さ１．７～２．３mmに形成したもの及び同変形量が３．３～３．７mmのコアにカバーを曲げ剛性が１０００～４０００kg／cm²の材料を用いて厚さ１．９～２．４mmに形成したものは特に使用感が良いことが認められた。

出願人　ブリヂストンタイヤ　株式会社

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EXHIBIT 5

SHINSHU SERVICES, INC.
JAPANESE LANGUAGE LEGAL SUPPORT AND CONSULTING

BRENDA K. SEAT, ESQ.

Certification

I, Brenda Kay Seat, do hereby certify the following:

I am fluent in the English and Japanese languages. I have translated and/or reviewed the translation of the Japanese document identified as:

Japanese Unexamined Patent 60-163673

and find it to be a true and accurate translation to the best of my knowledge and ability.

Signature B.K. Seat

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Specification

1. Name of the Invention

A Solid Golf Ball

2. Claims

1. A solid golf ball comprising a solid core formed from a high polymer compounding agent and a cover composed primarily with an ionomer resin, wherein, the solid core has a deformation of 1.5 to 4mm under a constant load of 100kg; and the cover uses a material having a flexural modulus of 500 to 4,000kg/cm^2 so that the thickness of the cover becomes 0.7 to 3mm.

2. A solid golf ball according to claim 1, wherein, the solid core has a deformation of 1.8 to 2.2mm under a constant load of 100kg; and the cover uses a material having a flexural modulus of 700 to 4000kg/cm^2 so that the thickness of the cover becomes 1.0 to 1.9mm.

3. A solid golf ball according to claim 1, wherein, the solid core has a deformation of 2.3 to 2.7mm under a constant load of 100kg; and the cover uses a material having a flexural modulus of 700 to 4000kg/cm^2 so that the thickness of the cover becomes 1.5 to 2.mm.

4. A solid golf ball according to claim 1, wherein, the solid core has a deformation of 2.8 to 3.2mm under a constant load of 100kg; and the cover uses a material having a flexural modulus of 900 to 4000kg/cm^2 so that the thickness of the cover becomes 1.7 to 2.3mm.

5. A solid golf ball according to claim 1, wherein, the solid core has a deformation of 3.3 to 3.7mm under a constant load of 100kg; and the cover uses a material having a flexural modulus of 1000 to 4000kg/cm^2 so that the thickness of the cover becomes 1.9 to 2.4mm.

3. Detailed Description of the Invention

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The present invention relates to solid golf balls such as two-piece golf balls having a solid core and an ionomer resin cover enclosing the solid core. More particularly, it relates to such solid golf balls having improved hitting feel and excellent durability.

Well known in the art are solid golf balls, for example, two-piece golf balls which are generally formed by milling polybutadiene rubber, methacrylic acid, zinc oxide or peroxide and thermoforming the composition into a solid core and covering the core with a cover. In these solid golf balls, for example, two-piece golf balls, ionomer resins having excellent cut resistance are generally used to form the cover. The solid golf balls having a cover formed of such an ionomer exhibit excellent durability. However, compared with conventional thread-wound balls, these solid golf balls show disadvantageous characteristics such as causing unpleasant hitting feel. Some attempts were conventionally made in the past to render the hitting feel of solid golf balls soft (1) by reducing the hardness of the solid core, (2) by thinning the cover having cut resistance, or (3) by molding the cover from a softer material. These attempts failed to produce satisfactory balls. Methods (1) and (2) resulted in balls having inferior durability, and balls tended to be cut easily when hit. With method (3), balls showed inferior initial velocity when hit.

As a result of many diligent studies to achieve the above-described objective and to obtain a solid golf ball having excellent durability and high initial velocity when hit, the inventors of the present invention discovered that a solid golf ball that has a solid core comprising of a high polymer compounding agent and an ionomer-resin cover enclosing the solid core, in which the solid core has a deformation of 1.5 to 4mm under a constant load of 100kg and the cover uses a material having a flexural modulus of 500 to 4,000kg/cm^2 so that the thickness of the cover becomes 0.7 to 3mm, achieves the objective very effectively.

More specifically, the inventors found that durability worsened when simply reducing the hardness of the solid core or thinning the cover in order to render the hitting feel soft or that the initial velocity dropped when simply molding the cover from a softer material. Instead, by combining a solid core having the hardness of the above-described range and a cover having flexural modules and thickness in the foregoing range, the golf ball unexpectedly exhibited soft hitting feel but did not reduce durability or initial velocity. Then, the inventors concluded that the golf ball having the equivalent hitting feel to that of a thread-wound ball was obtained when specifying the combination of the hardness of the core and the flexural modules and thickness of the cover. The present invention was thus invented.

The following describes the present invention in more detail.

The present invention provides a solid golf ball having a solid core formed from a high polymer compounding agent and a cover primarily composed with an ionomer resin. The solid core has a deformation of 1.5 to 4mm under a constant load of 100kg and the cover uses a material having a flexural modulus of 500 to 4,000kg/cm^2 so that the thickness of the cover becomes 0.7 to 3mm. The term deformation under a constant load of 100kg designates the distance of deformation of a spherical solid core occurring when a load of 100kg is applied to the core. The term flexural modules refers to the value measured using ASTM D-790-4.

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In the golf ball according to the present invention, when the solid core has a deformation of 1.8 to 2.2mm under a constant load of 100kg, it is preferable that the cover uses a material having a flexural modulus of 700 to 4000kg/cm^2 so that the thickness of the cover becomes 1.0 to 1.9mm. When the solid core has a deformation of 2.3 to 2.7mm under a constant load of 100kg, preferably the cover uses a material having a flexural modulus of 700 to 4000kg/cm^2 so that the thickness of the cover becomes 1.5 to 2.0mm. When the solid core has a deformation of 2.8 to 3.2mm under a constant load of 100kg, desirably the cover uses a material having a flexural modulus of 900 to 4000kg/cm^2 so that the thickness of the cover becomes 1.7 to 2.3mm. When the solid core has a deformation of 3.3 to 3.7mm under a constant load of 100kg, it is desirable that the cover uses a material having a flexural modulus of 1000 to 4000kg/cm^2 so that the thickness of the cover becomes 1.9 to 2.4mm. By making the hardness of the solid core, the flexural modulus and thickness of the cover within the above-described ranges, more assuredly a ball having improved hitting feel is obtained.

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There is no limitation to the composition of high polymer compounding material that forms a solid core having a deformation under a constant load of 100kg. A polybutadiene rubber can be formed using crosslinking agents such as unsaturated carboxylic acid or metallic acid thereof. A polybutadiene rubber can also be formed using crosslinking agents such as unsaturated carboxylic ester. A polybutadiene rubber further can be cross-linking formed using unsaturated carboxylic acid or a combination of unsaturated carboxylic acid and metallic salt thereof. The polybutadiene rubber compositions may be blended with a suitable amount of zinc oxide, organic peroxide, filling agent, etc. More preferably, for example, the solid core compositions are compositions containing 100 parts by weight of a polybutadiene containing 1-4 cis-bond, 10 to 30 parts by weight of acrylic and/or methacrylic acid, 10 to 70 parts by weight of zinc oxide, and 0.5 to 6 parts by weight of peroxide wherein the compositions are cured by heating.

The solid cores formed from the above-described compositions normally have a diameter of 36.4 to 37.4mm and a weight of 35.4 to 36.2g for the small size. For the large size, the cores have a diameter of 37.4 to 38. 4mm and a weight of 33.4 to 34.2g.

The covers are formed mainly from ionomer resins in the present invention. The compositions are suitably selected from resins mainly composed of ionomer having a flexural modulus of 500 to 4000kg/cm^2. The compositions of the cover material are not particularly limited. Exemplary compositions may be ionomer resins combined with inorganic filling agents including titanium dioxide, zinc oxide, zinc stearate, magnesium stearate. The preferred ionomer resins are polymers formed by polymerizing a monoolefin with one or more members selected from the group consisting of unsaturated mono-and dicarboxylic acids having 3 to 8 carbon atoms and esters thereof and adding a crossslinking metal linkage thereto.

The solid cores in the present invention may be molded by any conventional techniques, for example, by milling the ingredients of the solid core composition described above in a conventional mill such as a Banbury mixer or a roll mill, compression or injection molding the composition in a core-forming mold, and heating the molded core. The heating temperatures may be 140°C to 180°C when the core composition contains dicumyl peroxide as the peroxide curing agent. Also, the method of covering the solid core with the cover is not particularly limited. One method is by placing the solid core in a pair of cover halves preformed in a semispherical shape and thermoforming them into an integral ball. Alternatively, the cover composition may be injection molded over the solid core to form a core-cover integrated ball.

As described above, the solid golf ball according to the present invention comprising of a solid core formed from high polymer compounding material and a cover mainly composed of an ionomer resin, in which the solid core has a deformation of 1.5 to 4mm under a constant load of 100kg and the cover uses a material having a flexural modulus of 500 to 4,000kg/cm^2 so that the thickness of the cover becomes 0.7 to 3mm, exhibits improved soft hitting feel and excellent durability as well as high initial velocity.

The following are the embodiment and comparative examples to specifically describe the present invention.

[Embodiment and Comparative Examples]

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Solid cores were prepared by combining 100 parts by weight of a polybutadiene, 20 to 80 parts by weight of zinc oxide, 10 to 30 parts by weight of acrylic acid and 0.5 to 4 parts by weight of dicumylperoxide, milling the compositions in 1000α Banbury mixer and a roll mill, and compression molding them at 150°C for 40 minutes. Solid cores were prepared so that the diameters range 36 to 40mm and deformations range 2.0 to 3.5mm under a constant load of 100kg.

Cover compositions containing 100 parts by weight of an ionomer resin and 20 parts by weight of titanium dioxide were injection molded over the above-described solid cores to form two-piece golf balls comprising covers having the flexural modulus and thickness as shown in Table 1 through Table 4. As ionomer resins, resins were chosen from Himilan® having various flexural modulus. (The product numbers of Himilan® used for Table 1 to Table 4 are noted in the table.). Table 1 shows the results when the solid core has a deformation of 1.8 to 2.2mm under a constant load of 100kg, Table 2 when the solid core has a deformation of 2.3 to 2.7mm under a constant load of 100kg, Table 3 when the solid core has a deformation of 2.8 to 3.2mm under a constant load of 100kg and Table 4 when the solid core has a deformation of 3.3 to 3.7mm under a constant load of 100kg.

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Then, professional golfers hit these balls to evaluate the hitting feel. The results are shown in Table 1 to Table 4. Evaluation is made in three ranks.

Evaluation ranks
E: Hitting feel is soft and very good.
G: Feel between rank E and rank B.
B: Hitting feel is hard and not good.

According to the results of Table 1 to Table 4, solid golf balls in the present invention were proved to exhibit soft and improved hitting feel. It was proved that solid golf balls having the following conditions were particularly favorable in the hitting feel. When the solid core has a deformation of 1.8 to 2.2mm under a constant load of 100kg, the cover uses a material having a flexural modulus of 700 to 2000kg/cm^2 so that a thickness of the cover becomes 1.0 to 1.9mm. When the solid core has a deformation of 2.3 to 2.7mm under a constant load of 100kg, the cover uses a material having a flexural modulus of 700 to 2500kg/cm^2 so that a thickness of the cover becomes 1.5 to 2.0mm. When the solid core has a deformation of 2.8 to 3.2mm under a constant load of 100kg, the cover uses a material having a flexural modulus of 900 to 4000kg/cm^2 so that a thickness of the cover becomes 1.7 to 2.3mm. When the solid core has a deformation of 3.3 to 3.7mm under a constant load of 100kg, the cover uses a material having a flexural modulus of 1000 to 4000kg/cm^2 so that a thickness of the cover becomes 1.9 to 2.4mm.

Table 1: When the solid core has a deformation of 1.8 to 2.2mm under a constant load of 100kg

Cover Thickness (mm)	Flexural modulus of the cover (kg/cm^2) (Himilan® product No.)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1.0	E	E	E	E	E	E
1.5	E	E	E	E	E	B
1.75	E	E	E	E	B	B
2.0	G	G	B	B	B	B
2.25	B	B	B	B	B	B

Table 2: When the solid core has a deformation of 2.3 to 2.7mm under a constant load of 100kg

Cover Thickness (mm)	Flexural modulus (kg/cm^2) of the cover (Himilan® product No.)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1.0	B	B	G	G	G	G
1.25	G	G	G	G	G	G
1.5	E	E	E	E	E	B
1.75	E	E	E	E	E	B
2.0	E	E	B	B	B	B
2.25	B	B	B	B	B	B
2.5	B	B	B	B	B	B

Table 3: When the solid core has a deformation of 2.8 to 3.2mm under a constant load of 100kg

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Shinshu Services, Inc.
May 3, 2006

Cover Thickness (mm)	Flexural modulus (kg/cm^2) of the cover (Himilan® product No.)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1.5	B	B	G	G	G	G
1.75	E	E	E	E	E	E
2.0	E	E	E	E	E	E
2.25	E	E	E	E	E	E
2.5	G	G	B	B	B	B

Table 4: When the solid core has a deformation of 3.3 to 3.7mm under a constant load of 100kg

Cover Thickness (mm)	Flexural modulus (kg/cm^2) of the cover (Himilan® product No.)					
	714 (1856)	917 (1855)	1530 (1702)	1730 (1650)	2650 (1600)	3770 (1605)
1.5	B	B	B	G	G	G
1.75	G	G	G	G	G	G
2.0	E	E	E	E	E	E
2.25	E	E	E	E	E	E
2.5	G	G	G	G	G	B
2.75	G	G	G	G	B	B

Patent applicant: Bridgestone Tire Co., Ltd.
Agent: Patent agent: Takashi Kojima

EXHIBIT 6

REDACTED

EXHIBIT 7

APPENDIX III The Ball

1. Weight

The weight of the ball must not be greater than 1.620 ounces avoirdupois (45.93 gm).

2. Size

The diameter of the ball must not be less than 1.680 inches (42.67 mm). This specification will be satisfied if, under its own weight, a ball falls through a 1.680 inches diameter ring gauge in fewer than 25 out of 100 randomly selected positions, the test being carried out at a temperature of 23 + 1°C.

3. Spherical Symmetry

The ball must not be designed, manufactured or intentionally modified to have properties which differ from those of a spherically symmetrical ball.

4. Initial Velocity

The initial velocity of the ball must not exceed the limit specified (test on file) when measured on apparatus approved by the United States Golf Association.

5. Overall Distance Standard

The combined carry and roll of the ball, when tested on apparatus approved by the United States Golf Association, must not exceed the distance specified under the conditions set forth in the Overall Distance Standard for golf balls on file with the United States Golf Association.

EXHIBIT 8

REDACTED

EXHIBIT 9

REDACTED